NASA-TM-108064

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NEW ORLEANS DRINKING WATER PROJECT:
SUMMARY OF FIRST YEAR EFFORT AND CONCLUSION

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Supported through a Joint Agreement (502-92-02)
with NASA and the State of Louisiana

February, 1985

BACKGROUND

In 1983, the State of Louisiana's Office of Public Works requested assistance from NASA to develop an efficient, cost-effective system for removing trace levels of toxic and undersirable chemicals from Mississippi River water at New Orleans prior to final processing of the water for potable use. This request was the result of State officials performing a survey to identify potential methods at New Orleans that could also be scaled down for smaller applications at other locations along the river.

The subsequent agreement reached between NASA and the State of Louisiana provided for NASA to perform consulting services to the State as well as basic research necessary to design and operate a biological treatment system. Louisiana's support of this project based on new, inovative technology demonstrated a very progressive attitude toward solving some of our modern pollution problems. Other states such as California had already initiated large programs to develop new technology for solving their water shortage problems in southern California by reclaiming domestic wastewater. The City of San Diego, the State of California, and the U. S. Environmental Protection Agency have jointly agreed to finance 20 million dollars for the complete program. NASA scientists from the National Space Technology Laboratories participated in the design and review of operational data from the first 25,000 GPD pilot system. The system operated so successfully in processing raw domestic wastewater to potable water that the respective government agencies and organizations continued to support the larger one million GPD demonstration system. The new demonstration system basically consists of a primary settling basin, water hyacinth ponds, a reed/rock filter, alum precipitation, filtration, UV disinfection, low pressure reverse osmosis, ultrafiltration and chlorination in series.

For the past year NASA/NSTL has been conducting laboratory studies using river water collected from the East Pearl River spiked with an array of organics that have been found in the river water at New Orleans. In general, the spiked concentrations are considerably higher than those determined by the Jefferson Water Quality Laboratory on raw and processed Mississippi River water. The NASA laboratory analyzed the organics using extraction procedures developed by the Jefferson Laboratory and gas chromatography protocol approved by the U. S. Environmental Protection Agency.

The experimental system shown in Figure 1 consisted of a settling tank followed by three troughs connected in parallel and fed by split-flow plumbing from the settling tank. The river water was spiked with organics at time of collection. In the first studies, the three troughs were set up to represent a plant-free rock filter, a reed (*Phragmites communis*)/rock filter, and a water hyacinth (*Eichhornia crassipes*) system containing no rocks. The flow rates were set to achieve 3, 6, 12, and 24 hour retention times of the river water in each reservoir. Later the water hyacinth system was replaced with a bio-carbon filter for reasons to be addressed later. The organics and nutrient parameters were monitored on both influent and effluent samples. Results of this first year of effort are contained herein. Preliminary design criteria and recommendations for a pilot system on the Mississippi River at New Orleans are addressed.

RESULTS

The chemicals used to spike the river water can be separated into volatiles and base/neutral organics. The initial sample was the sample removed from the split flow point where the water was split into three equal fractions for treatment in each of the troughs. Mean results of the organic analyses as a function of retention time is presented in Table 1. Mean nutrient data is presented in Table 2. Data from the bio-carbon system is shown in Table 3.

The data indicates that a minimum of six hours detention time is needed for a treatment process based on biological processes. Breakthrough on organics was observed at three hour retention times. In all three of the initial troughs, the removal of volatile chlorinated aliphatics was a deficiency in the system. Water hyacinths did not perform as efficiently as the rock filters. In addition the recent, extremely cold winters have caused extensive damage and death to the water hyacinths used in open treatment systems at NSTL. A potable water treatment system must be designed with more reliability than the water hyacinths can offer in this area. Consequently, the bio-carbon filter system was substituted for the water hyacinths system. Bio-carbon implies the use of large mesh (   ) activated carbon that is not thermally regenerated, but rather biologically regenerated. Bio-carbon has very high absorptive properties. The effective retention time of organics is increased by several orders of magnitute over the liquid retention time. However, without the intentional culturing of microorganisms which adapt their enzyme systems to biodegrade organics into usable, non-toxic organics, the carbon filters would become saturated and leaching of organics from the filters or non-absorption of the organics would eventually be seen. A biofilm similar to the rock filters is allowed to form on the bio-carbon and create a self-regenerating system similar to the rock and reed/rock systems.

The model system at NSTL was maintained in a greenhouse, and consequently no other water entered the system due to rain or stormwater runoff. The daily mean temperatures experienced by the laboratory system were higher than an open system would be exposed to. An open pilot system's performance might indicate that longer retention times are needed in winter months unless a polyethylene or equivalent cover was used to retain solar heat. The reeds were harvested once during this first year of study.

CONCLUSIONS AND RECOMMENDATIONS

The data in Tables 1 and 3 demonstrate that a reed/rock filter is very effective in absorbing and biodegrading base/neutral organics and volatile aromatic organics. Six hour contact time is necessary to reduce the concentration of these organics from levels as high as 10μg/l to below detection limits. Effluent from a reed/rock filter should be post-treated with a one hour contact time in a bio-carbon filter in order to remove chlorinated aliphatics such as chloroform. Current studies are focusing on refining the kinetics of the bio-regeneration of the carbon filter, which is a new concept.

Criteria for the design of a settling basin to meet the needs of suspended solids removal at the levels experienced in Mississippi River water at New Orleans were derived by other members of the technical advisory committee. Figure 2 depicts a pilot system based on a settling basin followed by a reed/rock filter and a bio-carbon filter. The installation and evaluation of the proposed system is absolutely vital to insuring proper scale-up of this system to meet the demands of New Orleans.

At present, the best estimate of area needed for treatment is 0.5 acre of reed/rock filter per million gallons per day of river water. Another 0.1 acre of space is required for a bio-carbon filter receiving the same flow rate.

NASA has funded NSTL for the second year studies, but to date the State of Louisiana has not supplied matching funding for the second year.